SCIENCE

NEW YORK, DECEMBER 29, 1893.

FROST PLANTS: A RESUME.

BY D. T. MACDOUGAL, UNIVERSITY OF MINNESOTA.

PROF. LESTER F. WARD'S observations on the "Frost Freaks of the Dittany," in the *Botanical Gazette* for April, 1893, obtain more than a passing interest, since the phenomenon recorded—ever but little noticed, and recently almost forgotten—illustrates one form of the action of the woody tissues, and the medullary rays, in the movements of water in the plant stem.

Since the article mentioned and the accompanying cut may not be accessible to all of the readers of *Science*, it may be pertinent to say that the frost phenomena of this and other plants consist principally of the formation of very thin sheets of crystals of ice on the sides of the stem near the ground. These crystals are attached only by one edge, and extend their length of several inches out into the air in a sinuous or scroll-like form. The interpretation of the facts affording this phenomenon seems to the author to be of such importance as to justify their presentation here.

The first observation recorded is that of Stephen Elliot, who "notices a remarkable protrusion of icy crystals from the stems *Couyza bifrons*" (now *Pluchea bifrons*). (1824. Sketch of the Botany of South Carolina and Georgia, Vol. 2, p. 322.)

Sir John F. Herschel notices a similar occurrence on the stalks of the thistle and heliotrope, in the *London and Edinburgh Philos phical Magazine* (1833. 3d series, Vol. 2, p. 110).

Prof. S. R. Rigaud notices the analogous formation of ice crystals on a newly-built stone wall, in the same journal (l. c. p. 190).

The frost freaks of the dittany were first noticed by Dr. Darlington in his "Flora Cestrica" (1837. p. 350). In his description of the *Cunila Mariana* (the dittany) he says: "In the beginning of winter, after a rain, very curious and fantastic ribands of ice may often be observed attached to the base of the stems of this plant, produced, I presume, by the moisture from the earth rising by capillary attraction, and then being gradually forced out horizontally through a slit by the process of freezing The same phenomenon has been noticed in other plants." Referring to Helianthemum Canadense, he says: "Prof. Eaton and Dr. Bigelow have noticed the formation, in freezing weather, of curiously curved ice crystals near the root of H. Canadense" (l. c. p. 314).

Prof. John Leconte made a study of the frost-phenomena of *Pluchea bifrons* and *P. camphorata Decand.*, in November and December, 1848, along the coast of South Carolina and Georgia. The results of his observations, and a consideration of the results of some of the preceding workers, are given in the Proceedings of the A. A. A. S. for 1850, under the title of "Observations on a Remarkable Exudation of Ice from the Stems of Vegetables, and a Singular Protrusion of Icy Columns from Certain Kinds of Earth During Frosty Weather."

The frost phenomena noted by these several observers on the various plants agree in their general features, and it is only necessary to present the conclusions reached by Leconte in his lengthy and detailed consideration of the subject. The points which appear to be well established are:

1. The ice crystals on any plant are in the form of sheets, one to five in number, about three or four inches in width, and extending one to five inches from the plant.
2. The crystals are attached in longitudinal lines, following the medullary rays, in the portion of the stem immediately above the ground, around which they are arranged symmetrically or unsymmetrically.
3. The crystals appear to have their origin at the outer surface of the fibro-vascular ring, and protrude through slits in the bark, which has been ruptured in their formation. If the bark is strong enough to resist this rupture, the ice extends around the plant in the form of a thin layer of ice between the wood and bark.
4. When the crystals did not extend into the woody ring, they might appear in the same position several days in succession: if, however, the crystals extended through the wood along the rays, the wood split apart in the freezing, and no more crystals could be formed at that place.
5. The stems had ceased growing and were in all stages, from almost green to entirely dead; in all cases the stems were more or less saturated with water. The phenomena is entirely physical: similar formations are exhibited by certain soils.
6. The crystals are formed in the greatest profusion immediately after rainfall, and at a temperature slightly below 30° F.

All of these conclusions are fully warranted by the facts recorded, but when Professor Leconte sought an explanation of the actual movement of water in the plant stem necessary for the formation of the crystals, he was, of course, limited by the somewhat crude knowledge of plant anatomy current at that time. His reasoning that plants to show frost phenomena must be annual and herbaceous is entirely at fault, since the very plants upon which he worked are described by many botanists as biennials, as well as Helianthemum, on which the phenomenon is most frequently noticed. Again, while herbaceous stems doubtless furnish these crystals in greater profusion, the stem of Helianthemum is very woody and hard, with a relatively small section of pith. He reasons that the water "is drawn upward through the highly porous pith, while the wedge-shaped medullary rays secure the mechanical conditions necessary for the projectile force in the proper direction."

Of course, the water is drawn upward through the vessels near the pith, and is conducted laterally by the medullary rays. That the fluid does take this course in the dead stems was proven by the author, by allowing them to absorb and carry up colored solutions. It appears that the water is taken up by the simple saturation of the roots from the charged soil, without the intervention of the special activity of the root hairs, as is shown by the fact that plants dug up and replanted, which

would destroy the larger number of the root hairs, still formed crystals as usual. Then root pressure must be entirely wanting, as well as osmotic activity in plants at this stage. Neither can the elevation of the water be due to "negative pressure," since the portion of the stem above the crystal-forming part may be split, or broken, or cut entirely away, without affecting the formation of the crystals.

Capillary force is the only means by which the water may be carried from the ground up through the plant to where it forms crystals. The constant absorption and evaporation by the dessicating tissues limit the region of saturation and confine the formation of crystals to the basal portion of the stems. The size and arrangement of the medullary cells favor the lateral conduction of the water by reason of their greater capillary power. The portion of water at the peripheral ends of the rays is frozen and in expanding is forced outward. The portions which replace it are in turn frozen, and the successive increments thus formed give the length and account for the perpendicular striations of the ice riband. This is suggested by Professor Leconte, though he compares the whole ray with the capillary pores of the soil in its action. A temperature of several degrees below freezing point is necessary to overcome the capillary force, and freeze the water in the rays, which results in the splitting of the stem.

So far as can be learned from an examination of the stems of the "frost plants," the only structural conditions necessary are large and numerous vessels, thin-walled medullary cells in a well marked ray, and a bark easily split longitudinally. The category of plants furnishing these conditions is by no means small. And it seems highly probable that frost phenomena may be exhibited by any of these plants which may pass through the death stage at the season affording the necessary conditions of temperature and moisture.

I am indebted to Prof. Lester F. Ward for some of the references given above, as well as for other helpful suggestions.

QUANTITATIVE COMPARISONS: A COMMON ERROR OF LANGUAGE.

BY GEORGE H. JOHNSON, SC. D., ST. LOUIS, MO.

In expressing the degrees in which any object—using the word in its broadest or metaphysical sense—possesses a certain attribute or characteristic there must be understood a unit of comparison or measurement. To be comprehensible, this unit must be subject to the associative law of mathematics; that is to say, if subtracted from itself the remainder must be nothing, or the zero of the scale of comparision, if added to itself the sum must be twice itself, and if from the unit—supposed positive—there be subtracted a quantity greater than itself, the remainder must be negative. These facts, which seem so axiomatic as to make their statement superfluous, are frequently overlooked even by some eminent speakers and writers.

If we say that A is twice as long as B, we make B the unit of comparison and affirm that the length of B is contained twice in that of A, or, no length being the zero of linear measurement, the length of B is one unit and that of A is two units. Similarly, if we say that A is three-halves longer than B we have:

Length A = length B + 3/2 length B = 5/2 length B;

and if A is three-halves shorter than B we have:

Length A = length B – 3/2 length B = – 1/2 length B.

Now such a negative can occur only as indicative of reversed direction or position relative to the zero, and when no direction or position is assumed as positive the negative, as well as its imaginary roots, expresses the impossible. For example, when we say it is twice as far from A to B as from A to C, we have no reference to the positions or directions of the lines A B and A C, but only to their relative lengths, and a negative expression under these conditions is impossible in any system of mathematics.

A photographer advertised that by an improved process he could take pictures thirty times quicker than by the old process. Here, if T is the time required by the old process and T′ the time required by the new process, we have:

$$T' = T - 30\ T = -29\ T;$$

the negative T being the algebraic expression for "less than no time." Granting the claim of the advertisement, it necessarilly follows that the passage of time could be stopped or reversed at our pleasure and the rapidity of its backward flight would be determined only by the number of photographs taken by the new process in a unit of time. Amateur photographers will doubtless be pleased to know that they have the fountain of eternal youth so easily within their reach! It is true, however, that if an arbitrary assumption be made in regard to the zero of the scale of "quickness" the claim of the advertisement may be verified. For example, if we agree to take one second, s, as the zero of measurements, all increments constituting slowness and all decrements quickness, Q, then if $T = 59/60$ s we have $Q = 1/60$ s and $Q' = 30/60$ s, whence

$$T' = T - Q' = 29/60\ s;$$

so that the time by the new process would be nearly half the time by the old process. But the "thirty times quicker" was doubtless intended to mean one-thirtieth of the time, and so was a notable example of an unsuccessful and absurd attempt to make a quantitative statement.

A more remarkable example, because it occurred in a carefully written essay by an eminent scientist describing a variable star, is as follows:

"On April 27 it had become invisible in the great telescope. It was then one hundred and sixty thousand times fainter than it was at the time of discovery."

Now it is evident what would be meant by saying that it was one hundred and sixty thousand times brighter at one time than another, because brightness is an essentially positive quality whose quantity is dependent upon if not proportional to the amount of luminous energy eminating from the body; but faintness is a negative quality expressing only the absence of brightness; hence if there was no lack of brightness in the star when discovered, faintness at any other time could not be expressed comparatively by using any positive factor however large.

Considering the quotation grammatically the star is said to be "fainter" in the comparative degree; hence it is evident that it was first faint in the positive degree, and since no unit of faintness is used in photometry we can only assume that the brightness of the star in its positive condition of faintness as observed at discovery is the unit of comparison; hence when it was one hundred and sixty thousand times fainter it must have been (160,000–1) times less bright than an invisible body—since the latter, without luminous energy, has no brightness and presumably one unit of faintness.

After the author of the statement quoted has shown that 160,000 times fainter is equivalent to 1/160,000 as bright, which is doubtless what he meant, I will show that a liability of $1.00 is the same thing as assets of $159,999.00; and such a blessed discovery for insolvent debtors and their creditors would have so many degrees of brightness as to quite outshine any variable star!

SCIENCE:

PUBLISHED BY N. D. C. HODGES, 874 BROADWAY, NEW YORK.

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VARIATION IN SPORES OF CORN SMUT.

BY A. S. HITCHCOCK, MANHATTAN, KAS.

A DIAGNOSTIC character among cryptogamic plants is the size of the spores. Since the size varies it has been customary in descriptive works to give the spore measurements between the limits of observed variation. These limits show the actual variation, or nearly so, only when a large number of observations are made. It is well known that in many cases of original descriptions the measurements are founded upon too small a number of spores. But suppose the limit of variation is known, it is still desirable to know the usual size. There are only a few individuals that approach either extreme, and the greater number will lie near the average.

A curve might be constructed to show the variation of a given species by laying off abscissas representing equal differences in a given dimension and erecting ordinates whose lengths shall represent the number of spores having the corresponding dimension. If this curve descends rapidly from the maximum and afterwards gradually approaches the axis, it becomes more necessary to know the usual limits than the extremes, since spores lying near the extremes are proportionately more infrequent than where the curve approaches the axis of X more abruptly. The curve will probably always show two points of inflexion, and these two points will represent the usual limits.

In testing the matter by applying it to the measurement of corn smut spores I arrived at a somewhat unexpected result. Spores from several different sources were thoroughly mixed and samples from various parts of the mixture mounted in water. In taking the measurements, all the spores passing within convenient range of the micrometer were measured until about fifty observations were made. The results are in divisions of the eye-piece micrometer, each of which represents 3.85 μ. The 500 spores measured may be arranged as follows:

Diameter....	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
Number.....	3	2	18	67	92	89	66	41	38	28	21	20	10	4	1

Since it is rather difficult to estimate correctly 1/10 of a division on the micrometer, it will be well to unite the results in pairs. We shall then have:

Divisions	1.7	1.9	2.1	2 3	2.5	2.7	2.9	3.1
Number	5	85	181	107	66	41	14	1

If the curve is constructed for this set of measurements, we find that it is not symmetrical around the axis of Y. It is much steeper on one side than the other. The arithmetical mean does not represent the average diameter. The result shows that the curve is not that of the curve of probability which follows the law of variation in the physical world, but, in this particular case, follows the law governing biological variation. This difference between the laws of variation in the physical and living worlds has been nicely shown by Dr. C. S. Minot.[1] He shows that biological curves rise rapidly to their maximum and then fall on the other side much more gradually.

It will also be seen that over 50 per cent of the spores fall between 2.0 and 2.2, and that nearly 80 per cent fall between 2.0 and 2.5 inclusive.

A similar series of observations was made upon 300 pollen grains of *Acuida tuberculata*, but owing to the uneven surface there was more difficulty in making accurate measurements.

Divisions.........	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0
Number..........	4	10	47	67	96	5.5	9	5	3	3	1

The observer should be careful to measure all the spores in a given field, otherwise there is a tendency to pick out the very large and the very small ones, thus giving these too great a representation.

ON THE MEASUREMENT OF HALLUCINATIONS.

BY E. W. SCRIPTURE AND C. E. SEASHORE, NEW HAVEN, CONN.

IN an article on "Tests on School Children," by E. W. Scripture, in the *Educational Review*, 1893, V. 61, a test on suggestion was proposed, in which a wire was sometimes heated at a given signal and sometimes not. The observer, not knowing the facts of the case, was required to tell when the wire felt hot. When the wire was not heated, but the observer believed it to be heated, the time required for the hallucination to arise was measured.

This crude idea has been taken up on a larger scale this year, and measurements have been made on several persons in several ways. The work so far has been considered to be the preliminary or qualitative stage of the investigation. Before proceeding to the careful and laborious technical work necessary for exact measurements, which must necessarily take a great deal of time, we wish to secure priority rights as the first to measure hallucinations. In the first place, as the suggestion calling out the hallucination is a sensation or a compound of sensations, we can measure the intensity of the stimulus in the usual ways. In the second place, by finding that stimulus whose sensation is not perceptibly different from the hallucination, we measure the intensity of the hallucination. In the third place, by reacting to the hallucination we record the time required for it to appear; in more accurate work the reaction-time is to be subtracted from the total time, but as the hallucination-time in the cases already investigated ranges from seven to thirty seconds it was of no account. Our work has hitherto been confined to the weak hallucinations of sane people. We find very great differences, corresponding to classes of society and to training in scientific judgment. With abnormal persons we shall expect much shorter hallucination-time and much greater intensity.

[1] Proc. A. A. A. S., XXXIX., p. 271.

ON ROOT HAIRS.

BY TH. JAMIESON, ABERDEEN, SCOTLAND.

DURING the past fifteen years, in the course of carrying out a very large number of experiments to ascertain the relative effects of different forms of manure, and also, which of the mineral chemical elements usually found in plants are essential, no point was more strikingly illustrated than the inability of the plant to grow in the absence of phosphorus, although all the other essentials of growth were fully supplied. In its absence, the turnip plant, for instance, reached the stage of forming only leaflets, while neighboring plants, treated in every respect in precisely the same manner, only that they were supplied with phosphorus in addition, developed large plants, yielding a crop of about 30 tons per acre. No laboratory or lecture room experiment could be more effective than the positive and negative results shown by two such plots, side by side, and these evidences have been abundantly repeated annually.

In following out an inquiry bearing on this remarkable action, a special microscopic examination of root hairs was suggested; special in respect of introducing various conditions of light and shade, even approaching darkness, as well, of course, as adjustments of the focus under various degrees of light. This is specially mentioned in order to indicate that the feature on root hairs about to be explained is such as might easily escape notice in an ordinary examination. An unlooked-for structure was thus detected, as a consequence of attention being so long concentrated on the tip of the hair and of gazing continually on the spot under cautious and slight alterations of both light and focus. It was seen that there was *a well-defined aperture*. The aperture in the first case of detection was so clearly defined, and moreover seemed so clearly continuous with the inner membrane or tube of the hair cell, that no doubt was felt that there was an aperture. Possibly it would not have been discerned had it not been on an unusual part of the hair, viz.: a little below the point, so that the point formed a kind of cap. As a rule, however, the aperture is at the point.

So necessary is it to examine the root hair under varying conditions of light and focus, and also to travel along the inner lining of the tube with the eye till it reaches the point where the aperture ought to be, and so frequently is the aperture turned away from the point of view, that one familiar with the process can easily understand how any one not so familiar might rise from the examination and feel satisfied that the hair is, indeed, a a closed tube. Only persistence to continue, till the inexperienced observer falls upon a suitably placed hair, is followed by success.

After having observed so satisfactorily the first aperture, much time was spent during three years in examining the hairs of a large number of plants, and although from the state of the plant roots, and the condition and position of the hair, the aperture has frequently not been detected at the first examination, yet by another selection and persistent examination the aperture has been found without exception in the case of every plant examined.

On examination at this stage of the writings of the more eminent botanists on the subject, it was found that in few of these treatises is the detailed form of the hair gone into with sufficient minuteness.

The works of De Bary, Duchartre, Olivier, Gasparina, Van Lieghem, Sachs, Vines have been referred to.

The essential and accepted character given in all these works is: a complete and closed cell, thread-like in form and broadened at the base, where it is continuous with, and forms part of, the epidermis.

The more recent works by Schwartz, Zacharias and others dealing more particularly with root hairs have been examined, but the idea of an aperture does not seem to have occurred to them, and the negative evidence, of course, is not of any significance.

Referring now to the function of hairs as bearing on an aperture. None of the writers on the minute structure of hairs departs from the idea that the hairs are closed cells, or, as Sachs describes them, exceedingly delicate walled narrow tubes.

By accepting this view a difficulty arises. It has hitherto been found necessary to advance some explanation, for the well-known fact that the insoluble matter, such as phosphates, is assimilable by plants. Sachs says in explanation that these insoluble matters are without doubt dissolved in the thin layers of water which surround the particles of soil, basing this inference on the fact that water running off from the drained pipes of tilled soil contains these substances; but he infers further, that "since the nutritive materials clinging to the particles of soil are not soluble, or but slightly so in water, the roots must themselves effect the solution." This seems to be a kind of forced conclusion, *i. e.*, as the insoluble matter does get in, the particles *must* be dissolved, and, he asserts, without, however, giving grounds for it, that this solution is accomplished by means of the extremely thin membrane of the root hair being permeated with an acid fluid. Now, it is obvious that, it being once accepted that the root hair is a closed tube, and that side by side with this acceptance is placed the well-known fact that plants make use of insoluble matter, it becomes a necessity to assume, and it appears little more than an assumption, that the plants obtain their solids by the action of an acid. The usual statement is, not that the plant roots make use of an acid, but that they must make use of an acid, thus indicating that there was no other way of getting over the difficulty.

Van Tieghem also says that the roots set free an acid liquid which bathe their surface. He, however, undermines that statement by summarizing the functions of the root as a threefold action on the soil:

First—On the gases, by absorbing oxygen and disengaging carbonic acid.

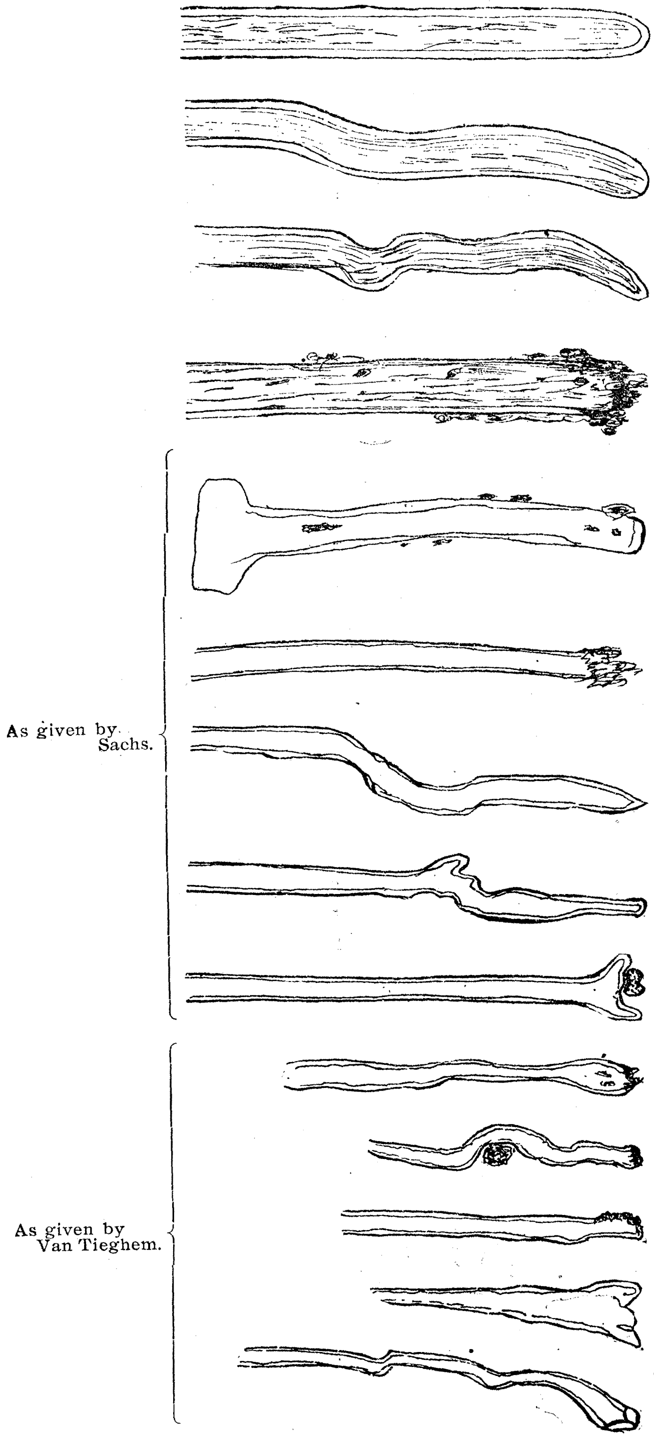
Second—On the water and dissolved matter, by absorbing them.

Third—On the solids, by dissolving them.

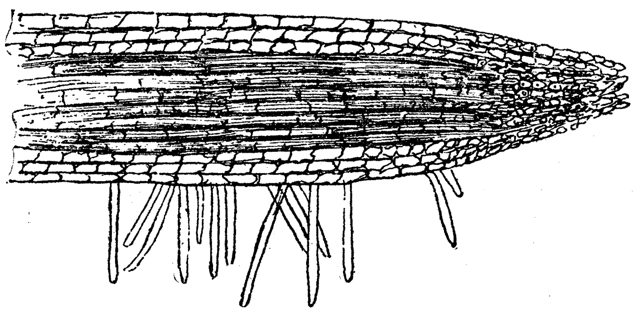
Now, it is evident that if the root acts so as to disengage carbonic acid, that acid alone is sufficient to account for the reddening of the litmus; and this circumstance takes away the support that such acid reaction might seem to give to the assumption that the plant forms an acid to dissolve the mineral food, unless, indeed, the dissolving acid be simply carbonic acid, in which case it would be uncertain whether the acid is there to dissolve insoluble matter, or is there as a simple product of decomposition. Vines asserts, however, that the reddening is permanent, and therefore is not due to carbonic acid.

Considering the slight evidence thus provided by Sachs and Van Tieghem, and that no observers seem to have found any special acid in the root, but simply acidity that may be accounted for by decomposition of the plant, or of organic matter in the soil, the dissolving action of the root hair seems to be little more than an assumption rendered necessary as an explanation of the well-known fact that insoluble matter is assimilated by the plant.

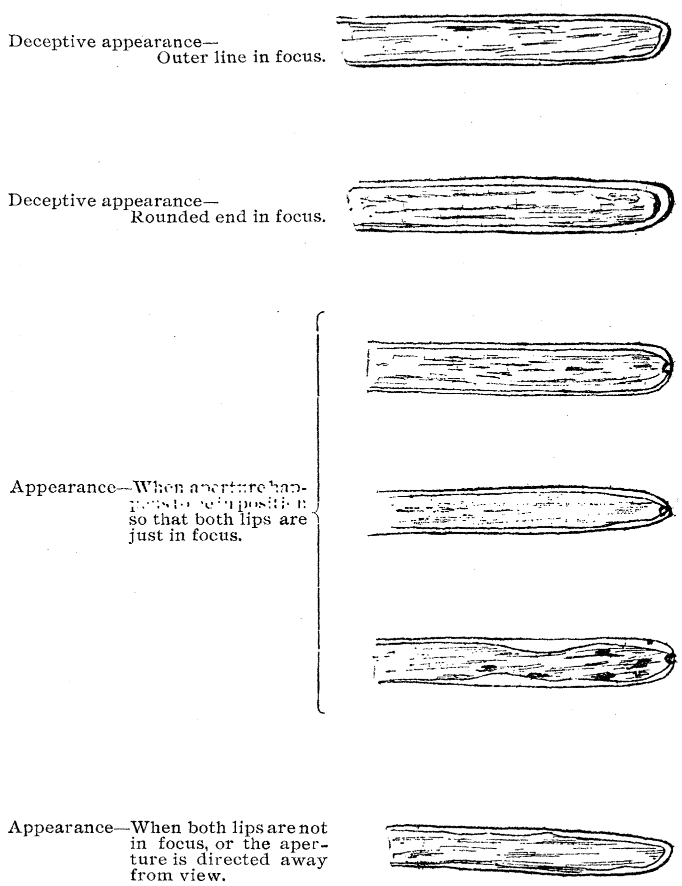
A difficulty in accepting the passage of solid particles by an aperture may seem to be presented by the consideration that, if solid particles enter the hair tip by an



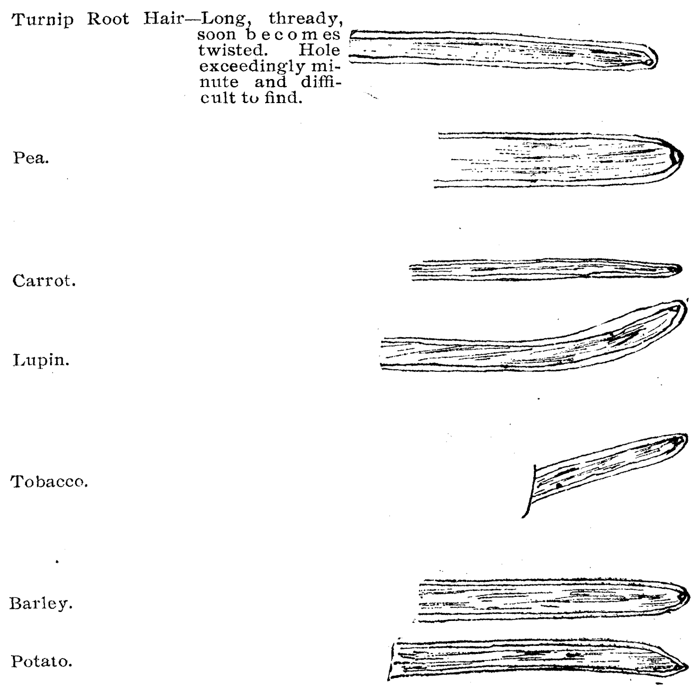
USUAL ILLUSTRATIONS OF ROOT HAIRS.



TIP OF OAT ROOTLET WITH ROOT HAIRS (much magnified.)



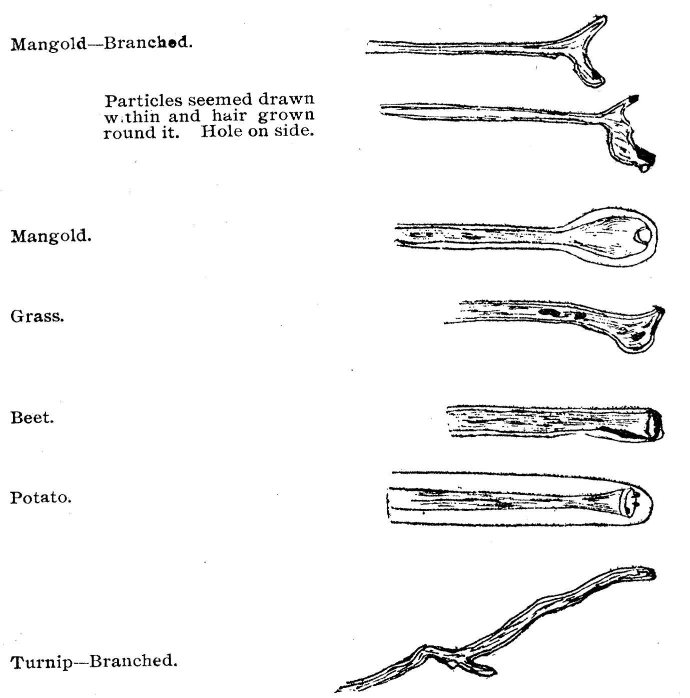
OAT HAIRS MORE MAGNIFIED.



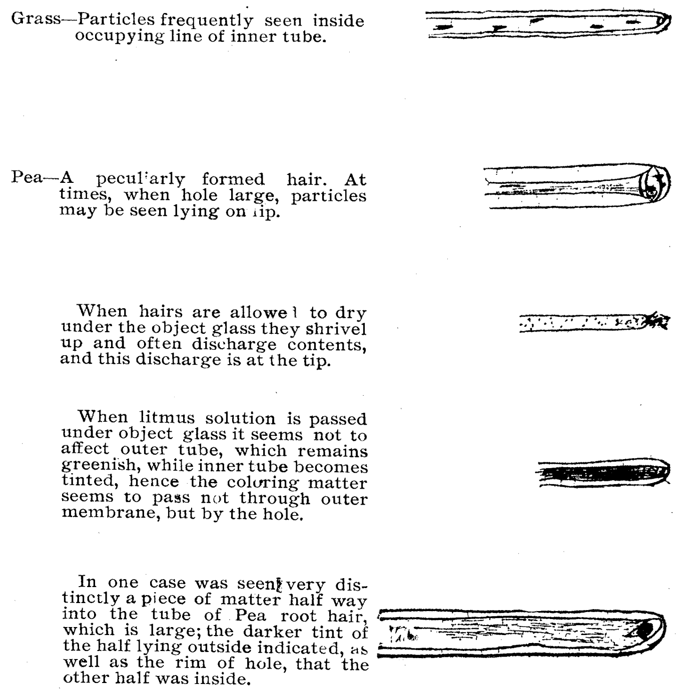
USUAL FORMS OF HAIRS.

aperture, they must either be decomposed inside the cell, or there must also be an aperture at the lower end, or that the particles should be forced out (as is done by the amœba). There may, indeed, be such a basal aperture which it would be difficult or impossible to distinguish. But close examination of the base of the root hairs indicates that, although they may originate in an epidermal cell, the internal part of the hair seems to communicate with the deeper tissue, or possibly with the vascular tissue. Thus in examining the root hair of a carrot, the faint bluish-grey appearance of the central tube was seen to be continuous with the deeper tissue, though whether entering into a vessel, or simply passing between the cells, could not be distinguished. This relation of the hair with the deeper tissue is supported by the origin of hairs as described by Schwartz and Duchartre. But there is no real difficulty here, for it is known that decomposition takes place within the plant, and it may as well be done in a hair cell as any other cell.

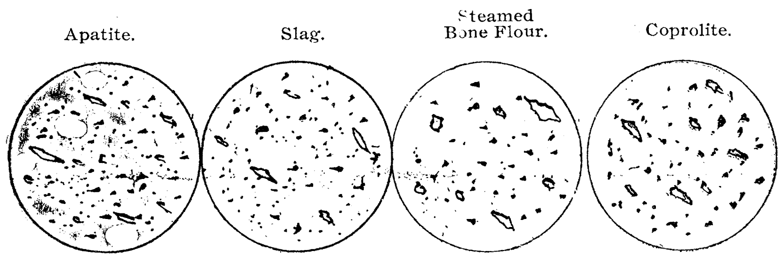
Having now considered the literature on the subject, observations made on the aperture may be returned to. That there is a definite formation of an aperture with lips, I have satisfied myself in regard to a large number of root hairs, illustrations of which are given here, and it will be seen that they vary not a little, both in shape and position, being usually a minute circular hole at the extreme, and more or less tapered, end of the inner tube, with, of course, a correspondingly larger rim in the outer tube; but sometimes the opening is transverse, sometimes not quite at the tip, or, rather, the tip seems half curved, making the aperture appear slightly at one side, and the tip to appear like a lip or knob.



UNUSUAL FORMS OF ROOT HAIRS. (Rarely occurring in the above plants.)



ENTRANCE OF PARTICLES INTO APERTURE.



	Actual Number in Field.				Number Per Cent.			
	Minute.	Small.	Medium.	Large.	Minute.	Small.	Medium.	Large.
Apatite	43	17	3	43	65	25	4	6
Slag	13	21	4	3	32	50	10	8
S. B. flour	110	15	3	2	86	11	2	1
Coprolite	56	35	8	4	56	34	7	3

STATE OF DIVISION OF MANURES EFFECTIVE ON PLANTS. (Apative—crystalline—only slightly so.) Showing that in these manures there are particles so minute as to be able to pass into aperture of root hairs.

LABORATORY WORK BY THE STUDENT OF CHEMISTRY SHOULD BE SUBORDINATE AND AUXILIARY TO THE DEVELOPMENT OF FACTS, PRINCIPLES AND THEORIES BY THE TEACHER.[1]

BY R. W. JONES, UNIVERSITY OF MISSISSIPPI.

THOSE of us who are engaged in teaching chemistry recognize the fact that it is a difficult subject to teach scientifically; it is ofttimes hard to make its lessons clear to the mind of the student; difficult to employ it with its due power as a means of intellectual discipline and an element of general, liberal education; and yet it has a place, an accorded place, in every properly arranged scheme of education: no such scheme is complete without it, and no one can be said to be liberally educated who has not learned the elements of this science; for without the knowledge of these elements, at least, it is impossible to read understandingly the literature of our day and to appreciate a thousand things of common occurrence in respect to health, well-being and progress. The practical utility of chemistry is unquestioned; but some question its disciplinary value as an element of general education. In my opinion, the skillful teacher makes its value in this regard equal to the languages and mathematics, and gives to the mind exercise and truth which in character are peculiar and in quality most valuable.

The great value of the study of general chemistry turns solely on the adoption of good, sound methods of instruction.

The nature of the subject, the inquiry into strange forces, into marvellous activities and changes, give to it, in the eyes of beginners, the appearance of the mysterious, making it seem, as it did to the Egyptians, a "Black or Secret Art." The puzzling vastness of the number of facts, the important and interesting relations between them, the comprehensive laws, the profound theories, tax the powers of the capable and patient student. The teachers and the writers of text-books often find it difficult to decide what to use and what to omit of this profusion of material. The subjects can be so selected, the matter so arranged with due regard to the time at our disposal and such methods of instruction employed that no other subject could be profitably substituted for the study of chemistry.

The methods of teaching general chemistry have varied greatly at different times and now vary more or less in different schools. Of course, each teacher carries his personality into his class room: this is right and inevitable; there are differences of method which are broader, proceeding from difference of standpoint and difference of view both of the object to be accomplished and the way of reaching it.

We cannot emphasize too strongly the general disciplinary value of the study of chemistry and its essentiality to culture; and it devolves upon us to maintain the correctness of our estimate by the intellectual and industrial results of our teaching. The first object is to use chemistry in a scheme of education to make intellectual men, and the second is to prepare skilled chemists.

After noting these differences of method, I am sure we may all agree that the feature which specially characterizes the teaching of chemistry at present and which distinguishes it from the method of past years is experimentation by the student.

And yet in many high schools and *colleges*, even in this day, the effort is made to teach chemistry without experiments either by the instructor or by the pupil. Many of these schools and colleges have no apparatus. Such teaching of chemistry and of science generally is illusory. Chemistry is justly and highly valued in its general study as an element of disciplinary power and as a foundation for special attainments; but its most earnest and intelligent advocates in a course for a well-rounded education would admit that it would be far better to omit it altogether than to teach it in that irrational manner without experiments, and to devote the time thus saved to the study of some subject which can be scientifically taught without apparatus.

As teachers, we must insist that an experimental science, such as chemistry is, cannot be taught without experiments.

In my judgment, the best method of teaching general chemistry, in the earlier part of the course, the best way of laying a substantial basis of knowledge that is reliable and definite, on which the student can subsequently build most surely and rapidly, is for the professor to give in didactic style oral lectures, adapted to the comprehension of his class, setting forth in order the most important portions of the great body of established facts, connecting them by threads of scientific relation, that bring them into a simple unity, illustrating them by experiments, on the lecture table, which cover all essential points and help the minds of students to apprehend them as real.

A really good text-book is very valuable, and the instructor ought either to follow the order of subjects in the text-book or be careful in assigning the readings so that the lectures and text-book will each day cover the same ground substantially. Otherwise confusion of thought will arise in the student's mind.

To indicate something of the scope of instruction I would say that there should be a clear presentation of the nature of chemical science, its relation to other sciences, and the ways of doing the work: there should be a discussion of the elements and their most important, best known compounds: as the teacher's knowledge covers his whole course he is able to call attention to that which is essential and that which may be at the time incidental, to note the connection between facts, the relation between substances, and thus to systematize and organize knowledge and build up the science in the minds of students: this prepares the way for the proper presentation and discussion of laws and theories, for calling into vigorous exercise the faculties of comparison and judgment. He can exhibit the method of properly guarded generalizations and formulations of his teachings; his duty and plan are to guard the student against the presumptuous thought that one man can make experiments to cover all the facts and phenomena and demonstrate all the laws of chemistry, and to impress on the mind respect for the work that has been patiently done by others and thus give a just regard for authority, through which so much of our knowledge comes in every department of inquiry: the pupil learns that for a satisfactory demonstration of chemical truths he needs a large complement of facts and processes.

At each meeting the class should be questioned upon the matter of previous lectures and readings; skillful repetition is needed to make distinct and abiding impress of the truths, to wear off the strangeness of the subjects and to get a lodgement of the facts and principles.

The careful keeping of notes, subject to periodical inspection of the teacher, the writing of chemical reactions and the solution of problems constitute an important part of that instruction which is necessary to exactness in method and clearness of understanding. It goes without saying that the student must be taught to

[1]Read before the International Congress of Chemists, Chicago.

make experiments. But in order to carry out this plan, the experiments to be made by him should be connected with the course of instruction and should be definitely related to the experiments given on the instructor's table. Indeed, the relation should be so close that a knowledge given by the instructor's experiments would be in large measure a guide to the performance of the student's experiments and that without it the successful performance of the practical work by the student would be beyond his power. This insures the closest attention and care on the part of the student to get the professor's instructions; it trains the mind to correct observation, concentration of energies and carefulness in drawing conclusions.

In the beginning of a course in general chemistry and for two or three months, one hour of laboratory work by the student to four hours of such instruction by the professor, as I have outlined, will be a good division of time. As the student's knowledge of the subject increases and his manual dexterity in handling apparatus improves, his working hours should increase. This mode of instruction proceeds on the rational assumption that the pupil needs to be instructed; it will furnish him the largest amount of reliable, systematic, classified knowledge that is attainable in a given time and give him the best foundation for extended scientific study.

Other special advantages of this mode of study will appear by comparison.

Many excellent chemists make laboratory experiments by the student the starting point and the centre of all instruction. Their idea seems to be to make the student do his own work, draw his own conclusions and thus instruct himself: the instructor, according to this method, gives him the fewest practicable hints and directions. In furtherance of this plan of instruction many "laboratory manuals" have been written which contain a great profusion of experiments: in many cases these are poorly arranged. In the preface to one of these "manuals," now open before me, I find these words: "The teacher should be but the guide that points out the right path, calling attention to the bypaths of error." This plainly implies that if only the direction be pointed out, the student can make the trip. This plan puts the student forward to work for unknown truth; it holds out to him the idea that in some sort he is an investigator, when in reality at first his work should be to learn what others have brought to light and how they have done it.

The objections to making the laboratory work of the student in the beginning the leading and independent method of learning chemistry are numerous and strong: 1. It involves an unnecessary consumption of time. 2. It assumes that the student can do properly what, in the very nature of the case, is well-nigh impossible. A certain amount of knowledge is necessary to the acquisition of other knowledge under the best conditions: there is hardly any fact more palpably true than this.

A student of algebra could hardly be expected to solve problems of any degree until he had the preliminary operations and rules that had been established by the patient work of strong, industrious minds. A traveller, ignorant of the topography and history of Rome, her archæology, her classic and Christian art, would not be profited by a visit to the famous city: he would stand unmoved before the ruins, the historic arches and temples and the treasures of her splendid galleries. A man sees what he has eyes to see. This principle applies in the study of chemistry. An untaught youth knows not what to expect, what to look for in an experiment; he sees things and knows not what is essential and important and what incidental and accessory. Many things he fails to see because he knows not what to look for and how to look. This brings him into a hesitating, doubting state of mind which is very unfavorable to definite, strong impressions. He does not know the significance of those actions which he observes, and he is unable to give them scientific interpretation and impression.

Chemistry is a great science, difficult to master: it has risen upon stepping stones of errors and obstacles by the continued efforts of great men. For centuries minds of able and laborious investigators reached out after the truth and battled against error. The advance from the unknown to the known has been very slow.

Glauber's "Sal Mirabile," Shahl's "Phlogiston" and various other propositions and hypotheses, strenuously advocated and rejected, tell us of the intensity of the struggle and how the mists of uncertainty hung over their work. But when Lavoisier availed himself of the labors of others, patiently compared facts with facts and generalized scientifically, he saw a new light, and the birth of modern chemistry was announced; chaos gave place to order; principles became harmonious.

In view of all this, is it not erroneous to require a student in the very outset to make and interpret experiments as the means of getting knowledge and to proceed with the most meagre knowledge to classify phenomena? Students at first should be put in possession of that knowledge which is their just inheritance from the history of the past and should have the opportunity of learning the methods of experimentation adopted by the builders of the science, and from this study of facts and principles and modes of manipulation to acquire the power of orderly thinking and get the key to higher and greater treasures.

When one wishes to enter upon research he carefully inquires what has been done already; he gets the bibliography, and learns the methods of investigation in that line that have been most fruitful of results: not uutil he has come to this point is he ready to enter upon the work which he proposes.

The object of work in the laboratory by the student in the beginning is to learn to use apparatus: his instruction must come mainly from the skillful teacher: the teacher is not merely "a guide" but a positive power in instruction, an intellectual quickener. The work of a student left to himself in the laboratory profits but little.

ORIGIN OF THE HYDROCARBONS.

BY MARCUS E. JONES, SALT LAKE CITY, UTAH.

A RECENT review of the paper of Dr. Engler on this subject in *Science* is an interesting one, as it is in the line with my own observations on that subject in Utah. The time-worn theory of the origin of our Utah hydrocarbons from coal has been repeated by several persons in *Science* during the past year, but unfortunately there is hardly a particle of evidence of such origin. I do not know of a single deposit near our coal beds in Utah, with perhaps the exception of one bed of impure asphalt, which seems to be close to the Dakota group, but may have come down from above, as it is not certainly interstratified with the Cretaceous beds. With this exception I do not know of any deposits of our hydrocarbons that are earlier than the Miocene Tertiary. There are some places where it is not possible to certainly tell whether some sandstones are Eocene or Miocene where asphalt has collected from adjacent beds of shale or clay. In using the word "near" it is used in a geological sense, i. e., stratigraphically near. There are some hydrocarbon beds which are within perhaps one-half a

mile of the upper coal beds but separated from them by the whole thickness of the Eocene and considerable of the Cretaceous. Again these deposits are always in the immediate vicinity of large deposits of bituminous shales or clays quite full of fish bones and the like but showing few or no vegetable remains. That a distillate should have come up from the far underlying Cretaceous coal beds through fissures and have spread out in certain beds only of the Miocene, while exactly the same conditions as to permeability prevail throughout the upper Cretaceous and Eocene with no hydrocarbons, would of itself preclude the supposed origin even if there were great fissures through which the material could come. In addition, however, there are no fissures cutting the formations where the deposits occur; the beds lie almost and often quite horizontally and show no signs of disturbance for the most part. Here and there are little irregular seams very rarely more than a foot wide, though in one case four feet wide, into which the hydrodarbon has oozed from the surrounding clays and made a deposit of the pure article. Were these fissures, which are evidently only local and shallow, the source and not the receptacle of the hydrocarbons, then the surrounding shales and clays would be saturated most at the point of contact and less and less as the distance from them increased, but the fact of the case is they are if anything less saturated at the point of contact and fully as much impregnated miles away from any fissures. Wherever we find even a seam the thickness of a knife-edge in these beds we find hydrocarbons, and where they are absent we find no deposits of hydrocarbons at all. The only beds which show a thinning out of their contained asphalts are the sandstones, which are nowhere evenly impregnated but are full of asphalt only where there is a crack or fissure leading up or down to the bituminous beds in the immediate vicinity. There are also several places where crude asphalt has oozed out of the sandstones and formed from a thousand to a million tons of matter more or less pure, assaying from 11 per cent to 75 per cent crude asphalt; the larger deposits are still flowing slowly, perhaps a barrel a day or the like. This material when it first comes out carries a large percentage of the more volatile hydrocarbons and considerable of the paraffine series, while the fixed carbons are low. To my mind these have the same origin as the other deposits, the connection with the overlying bituminous beds being very extensive through the small seams in the sandstones and the means of exit being the gentle slope of the beds. That the asphalt is composite is due either to the quantity and its wide origin or to lack of facilities for the volatilization of the lighter elements. Another remarkable feature in our hydrocarbons is that no two deposits so far discovered in Utah are alike in their chemical composition excepting the asphalts just mentioned. The so-called ozokerite at Pleasant Valley Junction is black and somewhat flaky, containing an excess of fixed carbon for one of the paraffines. Some fifty miles south is a deposit a few inches wide, containing a paraffine as pure as beeswax and of the same color, approaching closely to the typical ozokerite. At a place near Pleasant Valley Junction there are quite a number of seams of the asphalt series and one place where it oozes very slowly out of a layer in the bituminous shales and forms little balls which at length break off and roll down the slope. These have about the appearance of pure Trinidad asphalt and go low in the paraffines and contain small percentages of the lighter hydrocarbons. In the same region are several seams of the pure asphalt, none of them workable, in which the matter is as pure as the Uintahite or Gilsonite of commerce and has a fracture varying in the various seams from cubical to conchoidal, according to quantity of contained paraffine. A few miles farther north, but in the same geological horizon, are the only known deposits of what has recently been called Wurtzellite, which is an asphalt with an excess of paraffine. Some 100 miles farther, but in the same horizon, are the great deposits of Uintahite or Gilsonite, which has become so well known as a varnish and insulator. In my judgment these variances in composition are due to local causes, affecting the matter as it has oozed out of the shales into the crevices which have received it, such as exposure to the air, oxidation, etc.

Though the theory of the animal origin of our hydrocarbons, which was long ago ably advocated by Professor Newberry, seems to be the only tenable one, it must not be taken as proved by any means, for I have never yet seen sufficient remains of animals to account for the quantity of our hydrocarbons, though there may be sufficient in the beds as a whole. A significant fact is that these beds contain multitudes of tracks of birds and mud cracks indicating their being nearly on a level with the water. It is possible that many of the bones have disappeared by decay; this is plausible, since I have never found the bones of any animal intact but always scattered, broken and tangled in wild confusion, and yet plentiful.

The above remaks apply to the hydrocarbons of which mention has been made in *Science* and other journals. They are not the only ones in Utah, however. At the base of the Cretaceous, or at least as low as the base of the Colorado of Emmons, are other hydrocarbons wholly different from those mentioned above, which are nearly identical with the petroleum of the east, containing more paraffine only. So far they are not known to be extensive. In one locality there seems to be natural gas, but with what pressure is not definitely known,

In Salt Lake Valley is quite an extensive local deposit of natural gas of Pliocene age giving a pressure of at least 200 pounds to the inch. Its composition does not vary materially from that of the east, though it seems to give more heat and less flame.

BIRDS SELDOM SEEN IN SOUTH CAROLINA.

BY PROF. J. C. HARTZELL, JR., B. S., M. A. O. U., ORANGEBURG, S. C.

For some time the writer has been endeavoring to make a list of those birds that are uncommon in South Carolina. The undertaking has proved a very arduous task. The following is a partial list as the result of the undertaking. A fuller list is not given on account of the unsatisfactory data of a few species observed. The majority of the species noted below are in the writer's possession:

Clangula hyemalis; A. O. U. 154. Bays and coast in fall and winter. Food, shell-fish. Nest in long grass. Eggs bluish-white.

Grus americana; A. O. U. 204. Salt marshes and swamps. Food, Indian corn and sometimes mice. Nest on the ground. Eggs pale blue, spotted with brown,

Bonasa umbellus; A. O. U. 300. Hills, northwestern part of state. Nest under fallen log. Eggs white.

Aquila chrysætos; A. O. U. 349. Food, mammals and birds. Mountains in northern part of state. Nest on ledge of rocks. Eggs whitish.

Archibuteo lagopus sancti-johannis; A. O. U. 347a. Open fields. Nest in tree. Eggs whitish and drab. Food, field-mice.

Strix partincola; A. O. U. 365. Marsh lands and meadows. Food, rodents. Nest in old building. Eggs whitish.

Contopus barealis; A. O. U. 450. Pines and fruit trees. Food, insects. Nest in fork of pine tree. Eggs creamy with brown spots.

Corvus corax; A O. U. 486. Inaccessible cliffs. Food, birds, mammals and grains. Nest in very tall tree. Eggs light green, clouded with brown.

Plectrophanes nivalis; A. O. U. 534. Mountains. Nest in crevice of rock. Food insects in summer, seeds in winter. Eggs so varied in marking as to be indescribable.

Ammodromus condacutus; A. O. U. 549. Salt marshes. Food, shell fish and small crabs. Nest in grass. Eggs bluish white with brown spots.

Ammodromus maritimus; A. O. U. 550. Coast Nest on ground. Eggs grayish-white with brown spots. Food, shell fish.

Petrochelidod lunifrons; A O. U. 612. Jutting eaves. Food, insects. Eggs white with reddish-brown spots.

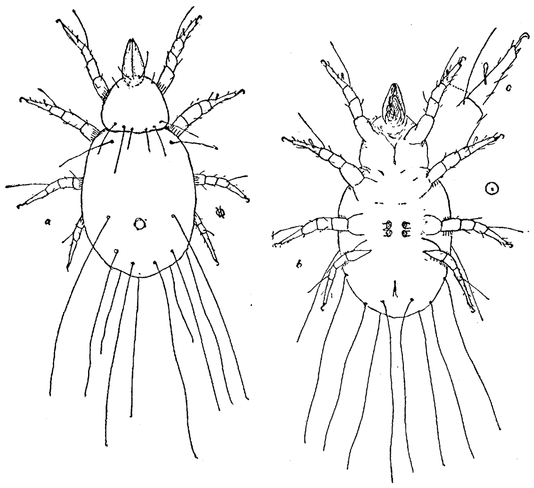
Vireo pheladelphicus; A. O. U. 626. Food, insects. Did not see nest or eggs.

Sitta canadensis; A. O. U. 728. Pine forests. Food, seed of pine tree and larvæ of insects. Nest in stump. Eggs bluish-white, with light red spots.

A NEW MITE INFECTING MUSHROOMS.

BY HERBERT OSBORN, AMES, IA.

SOME time since I received from Professor J. A. Lintner specimens of a mite which had been found infesting mushrooms quite seriously, and from its habits and the statements concerning its numbers it is likely to prove a very important pest of this crop. From the literature which is available it does not appear to be described and is certainly different from the species described as infesting mushrooms in Europe. It approaches more nearly to the *Tyroglyphus phylloxeræ* of Riley but is quite different in many structural details. Since it is likely to prove of importance it seems desirable to describe it, even though it may possibly prove identical with some of the described European forms.



Tyroglyphus lintneri, n. sp.
a, dorsal view. b, ventral view. c, tarsus, much enlarged; length shown in circle to right.
From nature, by H. Osborn.

Tyroglyphus lintneri, n. sp.—The mandibles are large, chelate, strongly toothed, the palpi terminating with a strong hook, the tarsi hooked with no sucker visible, the last segment long, slender, spiny at tip and on the two anterior pairs bearing a clavate appendage. The hairs are very long, those on the posterior part of the body equal to or greater than the length of the body and their origin marked by chitinous rings, six located on the posterior portion of the anterior division of the body and standing quite erect, ten on the posterior portion, two at anterior angles, two behind the middle and others near the margin on the posterior third of the body, abdominal suckers four, located between the abdominal legs.

This species differs from *T. phylloxerae* Riley, particularly in the greater length of tarsal joints, greater curvature of tarsal claw and the much greater length of the hairs, those at the end of the abdomen being as long or longer than the body, while the *phylloxerae* Riley describes as about one-third the diameter of the body. It is also larger than specimens I have determined as phylloxeræ, and the second pair of legs is further back on the body than shown in Riley's figure.

I have named it in honor of Dr. Lintner, who has taken a most lively interest in the various forms of acaridea, besides having made many valuable observations on these and other important insects.

THE ARCTIC CURRENT IN THE ESTUARY OF THE ST. LAWRENCE.

BY ANDREW T. DRUMMOND, MONTREAL, CANADA.

THE great Arctic Current of northeastern America takes its rise in Baffin's Bay and, after skirting with its broad surface the coasts of Labrador and Newfoundland, appears to largely lose itself as a cold surface current, as it impinges on, and, in part, parallels, the Gulf Stream. Every traveller to America by the St. Lawrence route has his attention drawn forcibly to it by the coldness of both the atmosphere and the water, and by the presence of the picturesque icebergs, which, though floating slowly southward with the current, suggest to the imagination a broad submerged mountain chain with the glaciered topmost peaks and snow-clad pinnacles alone left to view.

As the great steamship passes inward to the Gulf of St. Lawrence by the Straits of Belle Isle, the traveller is equally struck with the fact that although the current appears to have been crossed, huge bergs are still met with, floating in a new direction toward Anticosti. The explanation is that a branch of this Arctic or Labrador Current finds its way through the Straits of Belle Isle and past Anticosti to the River St. Lawrence, up the estuary of which it ascends on the northerly side toward Quebec. On the way it meets with and is tempered by the warmer waters coming from the Great Lakes above, as they pass outward to the sea, and returns on the south side of the estuary as a modified current, which, after skirting the Gaspe Peninsula, is finally lost in the Gulf of St. Lawrence. This is the substance of our present knowledge.

The temperature of the water in the estuary of the river becomes interesting as bearing on the existence of this current. During the early part of August, last, the opportunity presented itself at Murray Bay, on the north shore, of obtaining some surface and bottom temperatures. The instruments used were Negretti and Zambra's reference and deep-sea thermometers. The conditions on the 5th of August, when the following readings at different points were taken, were those of calm air, clear sky, and fairly strong sun; the time, 8 A. M. to 8:30 A. M., and the position about a mile and a half off Cap a l'Aigle, a jutting headland four miles below Murray Bay village:

	1	2	3
Air........................	59° F.	——	59½° F.
Water on surface.......	46¼°	46½° F.	46¼°
Water at 17 fathoms....	——	——	38¼°
Water at 18 fathoms....	38½°	——	——
Water at 31 fathoms....	——	38½°	——

Whilst the surface water at this distance from land was comparatively cold, at the shore at Cap a l'Aigle, where it flows and reflows over the rocky shallows, its temperature on warm days was generally from 53° to 60° F., thus admitting of bathing on the part of the summer residents.

LETTERS TO THE EDITOR.

***Correspondents are requested to be as brief as possible. The writer's name is in all cases required as a proof of good faith.

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

A Rope of Maggots.

The following bit of experience is given in the hope that some well-informed person will shed light upon the subject.

I was hurriedly passing through a wood one damp summer morning when my attention was drawn to what appeared to be a piece of rope lying among the leaves. It was not at all unusual to find short pieces of rope in the pastured woods, but something unusual in the appearance of this one attracted my attention at once. It was moving! not in a forward or backward, nor in a sidewise, direction; nor rolling over, nor in the least changing its position or shape. In the dim light of the woods I could make it out only by stooping down with my face close to it. Then I discovered that it was composed of maggots!

The rope tapered like a whip-lash, which it very closely resembled, being about five feet long, nearly two inches in diameter at the large end, fully two inches at the largest part, and tapering from there to a thin line at the "lash" end. It was in the form of a section of a circle about twenty feet in diameter.

Each maggot seemed to be in motion toward the large end, wriggling over or between or below his fellows. During the five minutes that I watched them there was an advance of four inches, the van of the mass wriggling on the leaves ahead of the rest.

My first thought was that they were feasting on the cadaver of a snake. But there was not the least evidence of a snake. Since all seemed to be migrating, I concluded that they had finished one mess and were seeking another. But I was unable to find anything which they could have hatched in or come from, in any direction, nor any hole whence they might have issued. For nearly two feet in the rear of the moving mass there were traces of them, indicating that they had travelled over that space. Further than that no traces could be found.

Some questions naturally suggest themselves. If the maggots were really migrating, how came they to be in that shape rather than spread out over a larger surface? If they simply occupied carrion which assumed this shape, why were they all moving in one direction? It is not at all unusual to see a great mass of maggots move simultaneously when there is some exciting cause. But these did not have that appearance. They were trying to get somewhere! If they had been feeding upon carrion, why should there be not the slightest remains of it? I hope that some one may be able to throw some light upon this. As near as I could determine, the maggots belonged to the *genus Musca*, and very closely resembled, if they were not identical with, the common house fly (*M. domestica.*)

Lynds Jones.

Oberlin College, Oberlin, Ohio.

Singular Behavior of an Owl.

When collecting plants in the summer I came across an owl standing at the base of a small shrubby oak in a thinly wooded pasture. It was discovered when about twenty feet away, and was cautiously approached in order to get a better view, and to see how it would act. When I had come within eight or ten feet it fluttered away about as far in the opposite direction, turned partly on its side and spread its wings a little, much as a wounded or fallen bird does. I went up to it, took it from the ground and carefully examined it, expecting to find some wound or mark of disability for flying, but could find none. While doing this it was held in the hands either by the wings, feet or body, the bird quietly submitting or only slightly flapping the wings. After satisfying my curiosity I set it down, not wishing to carry it about all day in order to take it home, for it was not yet noon. To my surprise it immediately flew off several rods with as much apparent ease as any bird possessed. I watched to see where it lighted, and found it in an open place amid the rushes of a dry slough. Being curious to see whether it would repeat the former tactics, I again approached it cautiously, but got scarcely as near as before, when it took wing again and flew still farther off. It was sought once more, and found in a similar place, but had become more wary, so that I could not get very near before it flew so far away that I did not care to follow it up, having become well satisfied that the owl was physically sound, and knew quite well how to care for itself.

It at once became a question why the bird had acted so strangely at first. Was it surprised and bewildered, or dazed by the sunlight, or did it make a deliberate effort to deceive? To decide by the behavior, since one cannot tell what may be passing in the bird-mind, the last offers the best explanation. Though walking quite briskly when the owl was first seen, I at once checked my step, and paused for a little before going nearer. The bird evidently saw me about as soon as I saw it, for its face was towards me, and it watched my movements. How well an owl can see in the day-time I am not prepared to say, though it readily perceived me by some sense on the two subsequent occasions of approach when I was quite a piece away. Hence the attitude it took, its non-resistance when taken in hand, and its submissiveness when undergoing inspection, led me to infer that the owl wished to pass for a worthless fellow, if not dead, and cause me to go by and let it alone. But it evidently came to a different conclusion after the first trial and did not care to run further risk, or trust me longer. From its size and markings it was judged to have been the short-eared owl, *Brachyotus palustris* of authors.

E. J. Hill.

Englewood, Chicago, Dec. 22, 1893.

On Carib Migrations.

In *Science*, Dec. 15, p. 334, it is said, referring to the Caribs, "It would seem strange if a people who could navigate the Caribbean Sea in large open boats were incapable of crossing from Cuba to Florida."

The assumption appears to be that some Caribs lived on the island of Cuba. What authority is there for this? Is it any more strange that the Caribs did not reach Florida than that the Mayas and the Island Arawacks did not? Both of whom were equally skillful navigators. Or, because they were capable of doing so, are we to assume that they did? Not an element of the Carib language has been found anywhere north of the Isthmus of Panama.

D. G. Brinton.

Philadelphia, Dec. 27.

Pocket Key of the Birds of the Northern United States.

In the notice of my "Pocket Key of the Birds of the Northern United States" in *Science* for Dec. 15 it is said that it "will enable a student of nature to determine

the family and usually the genera of any of our northern birds."

As it attempts to trace them all to the *species*, I think the notice should say so, and, if it is a failure in that attempt, say that also, and not lead readers to think I would write a book to enable a hunter to find out merely that the bird he shot is a snipe rather than a duck.

AUSTIN C. APGAR.

Trenton, N. J., Dec. 27, 1893.

BOOK-REVIEWS.

The Science of Education, Its General Principles Deduced from Its Aim, and *The Aesthetic Revelation of the World.* By JOHANN FRIEDRICH HEBART. Translated from the German with a Biographical Introduction by Henry M. and Emmie Felkin and a Preface by Oscar Browning, M. A. Boston, D. C. Heath & Co. 268 p., 1893.

PROBABLY no feature of our intellectual culture and of our advancement in higher education is so significant as the growing library of pedagogics in this country. For a number of years this department of thought has been sadly neglected with us, while abroad it has long received due attention as a most important factor in philosophic progress. Particularly with the German thinkers has this subject proved most fruitful, but, unfortunately, the peculiar difficulties of philosophical German have limited the English-speaking readers of these works to a favored few who, maybe, from residence abroad have acquired that thorough knowledge of the language necessary. Mr. and Mrs. Felkin have certainly then earned the applause of all teachers and thinkers by their careful and conscientious translation of these most valuable works of Hebart. Hebart himself is known by little more than name in this country, though some may recall him as a former professor at Göttingen, whose works on psychology and education are of great value; and yet as a metaphysician, psychologist, philosopher and teacher few men are deserving of so much careful study.

In the introduction to the present work we have a charming biographical sketch of the author, revealing in its carefully selected details glimpses of the inner man and offering a series of pen pictures of great value and assistance to the proper appreciation of the discussion which follows. Through his childhood, at Jena, at Bremen, at Göttingen, at Königsberg, we follow the author in his development, if development it can be called, when from their inception his theories seem to be those of mature growth and profound contemplation. Following this entertaining sketch the translators have given a review of Hebart's philosophy, together with a synopsis of the two works which follow and form the principal portion of the book. The review has evidently been written from a thorough acquaintance with Hebart's writings and is an additional aid to our understanding of his principles. "The whole aim of education, according to Hebart, is contained in the one word, morality. Its whole work is to form a character which in the battle of life shall stand unmoved, not through the strength of its intermal action, but on the firm and enduring foundation of its moral insight and enlightened will." "Proceeding from morality as the highest aim of humanity, and consequently of education, the essence of formation of character is defined as 'a making' which the pupil himself discovers when choosing the good and rejecting the bad. This rise in self-conscious personality must take place in the mind of the pupil himself, and be perfected by his own exertion. To place the power already existent, and in its nature trustworthy, in the midst of such conditions that it must *infallibly* effect this rise, is what the teacher must conceive as possible—while he must consider the great work of all his efforts is to reach, understand and guide that power."

Industrié des Cuirs et des Peaux, Analyse des Matières Premières, des Agents Auxiliaries et des Products. Par FERDINAND JEAN. Paris, Gauthier-Villars et Fils. 195 p., 1893.

Fabrication des Vernis, Application à l'Industrié et aux Arts. Par LAURENT NAUDIN. Paris, Gauthier-Villars et Fils. 200 p., 1893.

Decoration Céramique au Feu de Moufle. Par M. E. Guenez. Paris, Gauthier-Villars et Fils, Quai des Grands-Augustines, 55. 199 p., 1893.

We have already noticed in these columns previous numbers of the *Encyclopédie Scientifique,* of which these present volumes form a recent addition, and further remarks on the general excellence of the plan adopted would be unnecessary. The detailed but concise descriptions of the individual arts and sciences, with separate volumes, each devoted to some particular speciality or division of the whole, and each complete in itself, is an undertaking sufficiently vast to make a doubt as to its success perfectly natural. But under the directorship of M. Leanté, Membre de l'Institute, and of M. Masson, editor, this success has certainly been attained, and we are presented with a series of works each superior in its particular field, and of value to a specialist as well as to the general reader. The first volume, treating of the tanning industry, naturally appeals most strongly to the manufacturer and to the chemist. The discussion consists, in brief, of the study of the crude materials and the chemical products which are introduced, of the theory of the successive operations of manufacture and their practical manipulation. Methods of analysis are also given, and in such a manner as to be intelligible to the manufacturer as well as to his chemist.

The manufacture of varnishes, by M. Naudin, is divided into two parts, the first treating the theoretical side and including the analysis of the resins and oils, with brief notice of the manner of extraction of the same, and their origin both geographical and botanical. The second part treats of the principal processes of manufacture actually used in this branch of industry.

The art of china and pottery decoration is so widespread and includes among its devotees so many amateurs, as well as those working upon a larger scale, that this little book of M. Guenez will doubtless prove profitable to many readers. Those "little points" which one soon discovers to be so essential to success are here described in principle and in practice, and by an understanding of the cause of the failure repeated disappointment is avoided. In pursuance of this plan the first part of the book deals with the theory or chemistry of china painting, while the second describes in detail the methods used in practice. While sufficiently popular to prevent no serious difficulties to the amateur, this book is of greatest value to the industrial worker.

NOTES AND NEWS.

Mrs. J. R. Green's "Town Life in the Fifteenth Century" is nearly ready. It will be of undoubted interest to the general reader as well as to the student of political economy, dealing, as it does, with the days when the towns were independent communities and centres of political life. "There is nothing in England to-day," writes Mrs. Green, "with which we can compare the life of a fully enfranchised borough of the fifteenth century, . . . a state within a state, boasting of rights derived from immemorial custom and of later privileges assumed by law."

—Mr. J. Norman Lockyer, the author of "The Meteoritic Hypothesis," "The Evolution of the Heavens and the Earth," and many other important works, has in press a new book, "The Dawn of Astronomy." It tells of the days when wonder and worship formed the prevailing feature in any consideration of the heavenly bodies; and it traces in Egypt and Babylonia, in China and India, the beginnings of the scientific treatment of the subject. The numerous illustrations lend another feature of interest to this delightful book.

Exchanges.

[Free of charge to all, if of satisfactory character. Address N. D. C. Hodges, 874 Broadway, New York.]

Skins, with full data, of Ægialites nivosa, Ereunetes occidentalis, Ammodramus beldingi, A. rostratus, Chamæa fasciata henshawi and others from California, for native or foreign skins with full data. A. W. Anthony, 2042 Albatross Street, San Diego, California.

For Sale.—An entirely new analytical balance, made by one of [illegible]; capacity [illegible] grammes, sensitive to one-twentieth a milligramme. Never been used. Regular price, $8[illegible]. Will sell for [illegible] cash. Address, A. P. Nichols, 41 Summer Street, Haverhill, Mass.

Museum of Hamline University desires to exchange Marine Shells, preserved alcoholic material of marine zoology, or microscopic slides for zoological specimens from southern and western United States, especially for rodents in the flesh. Correspondence solicited. Address Henry L. Osborn, Biological Laboratory of Hamline University, St. Paul, Minnesota.

For Sale.—Small collection of fine first-class sets of birds' eggs; single breech-loading shotgun, gold-filled hunting-case watch and telescope. Write for list of eggs and particulars. B. S. Bowdish, Phelps, N. Y.

I am desirous of obtaining the following back numbers of *The Auk*: One copy each of Oct., 1885; July, 1886; January, 1887; July, 1887; April and July, 1891 and two copies each of the following: January, 1886 Oct. 1886; Oct., 1887; July, 1888; January, 1889; January, 1890. My own contributions in them only are required; otherwise the copies need not be perfect. I have in exchange for them two vols. (zoology) Mex. Boundary Surveys (col. plates) or complete set of English reprints of "Osteology of Arctic Water-Birds, etc." (9 parts, 24 lith. plates); or other rare scientific reprints of any subject required. Address Dr. Shufeldt, Takoma, D. C.

Wants.

Wanted.—Sachs's Text-book of Botany, 2nd English edition. Dr. Alfred C. Stokes, 527 Monmouth Street, Trenton, New Jersey.

WANTED to exchange for human bones or recent medical text-books, the following books "Metallurgy of Silver," M. Eissler, 1889; "Practical Treatise on Petroleum," by Benj. J. Crewe, 1887; "Cook's Chemical Philosophy," [illegible]; "Cairn's Chemical Analysis," [illegible]; "Wagner's Chemical Technology," by Crookes, 1886; "Fresemier's Qual. Chem. Analysis," 1879; "Elementary Treatise on Practical Chemistry and Qual. Analysis."—Clowes, 1881; bound Vols. 1 to 12 of Dr. Lardner's "Museum of Science and Art" (very rare), 1854; back numbers of "Electrical World," beautiful specimens of Pyrite Incrustations from Cretaceous of New Jersey; Magnetis Iron Ore, Highly Polarized. Address D. T. Marshall, Metuchen, N. J.

WANTED.—Books or information on the microscopical determination of blood and hair. Also reports of cases where hair has played an important part in the identification of an individual. Address Maurice Reiker, 206 N. First Ave., Marshalltwn, Iowa.

A GEOLOGIST thoroughly conversant with the geology of the Southern States desires an engagement. Has complete knowledge of the economic geology of Iron, Coal, Lignite, as well as Clay and Kaolin. Five years' experience with Geological Surveys. Address K., 509 West Sixth Street, Austin, Texas.

WANTED.—Tuckerman's Geneva Lichenum and Carpenter on the Microscope, Wiley's Introduction to the Study of Lichens. State price and other particulars. Richard Lees, Brampton, Ont.

SOME OF THE NEW BOOKS AT LOW PRICES.

FAMOUS VOYAGERS AND EXPLORERS.—$1.50.

MRS. BOLTON has added to her *Famous* series of books another and an unusually interesting volume, "Famous Voyagers and Explorers." It is hardly comprehensive, as it gives the biographies of only a few typical explorers—Marco Polo, Columbus, Magellan, Raleigh, and the more prominent of our modern American explorers. Doubtless such names as the Cabots, Sir Humphrey Gilbert, De Soto, Cartier, Nansen and others are reserved for a second volume. Mrs. Bolton has a gift for this sort of writing, and she has here brought together a large amount of deeply interesting matter which otherwise could only be obtained by reading through a dozen or more separate volumes. The book is illustrated with several portraits.—*Boston Transcript.*

OUR GREAT WEST.—$2.50.

THE contents of the volume appeared serially in *Harper's Magazine* and *Harper's Weekly*, in which periodicals they attracted wide attention and favorable comment. Their importance fully justified their republication in a more permanent form. The book affords a more minute insight into the present condition of the West than can be found elsewhere. What it tells is the result of personal experience, fortified by information obtained from the best-informed and most reliable men in the localities under discussion, and set forth with admirable clearness and impartiality. It is a work to be read and pondered by those interested in the growth of the nation westward, and is of permanent standard value.—*Boston Gazette.*

STATESMEN.—$2.00.

IN the preparation of this work Noah Brooks has aimed to present a series of character sketches of the eminent persons selected for portraiture. The object is to place before the present generation of Americans salient points in the careers of public men whose attainments in statesmanship were the result of their own individual exertions and force of character rather than of fortunate circumstances. Therefore these brief studies are not biographies. Mr. Brooks had the good fortune of personal acquaintance with most of the statesmen of the latter part of the period illustrated by his pen, and he considers it an advantage to his readers that they may thus receive from him some of the impressions which these conspicuous personages made upon the mental vision of those who heard and saw them while they were living examples of nobility of aim and success of achievement in American statesmanship.

MEN OF BUSINESS.—$2.00.

W. O. STODDARD, who has just written a book published by the Scribners, on "Men of Business," tells how the late Senator Stanford chopped his way to the law. "He had grown tall and strong," says Mr. Stoddard, "and was a capital hand in a hay-field, behind a plough, or with an axe in the timber; but how could this help him into his chosen profession? Nevertheless it was a feat of wood-chopping which raised him to the bar. When he was eighteen years of age his father purchased a tract of woodland; wished to clear it, but had not the means to do so. At the same time he was anxious to give his son a lift. He told Leand, therefore, that he could have all he could make from the timber, if he would leave the land clelar of trees. Leland took the offer, for a new market had latterly been created for cord-wood. He had saved money enough to hire other choppers to help him, and he chopped for the law and his future career. Over 2,000 cords of wood were cut and sold to the Mohawk and Hudson River Railroad, and the net profit to the young contractor was $2,600. It had been earned by severe toil, in cold and heat, and it stood for something more than dollars.—*Brooklyn Times.*

ORTHOMETRY.—$2.00.

IN "Orthometry" Mr. R. F. Brewer has attempted a fuller treatment of the art of versification than is to be found in the popular treatises on that subject. While the preface shows a tendency to encourage verse-making, as unnecessary as it is undesirable, the work may be regarded as useful so far as it tends to cultivate an intelligent taste for good poetry. The rhyming dictionary at the end is a new feature, which will undoubtedly commend itself to those having a use for such aids. A specially interesting chapter is that on "Poetic Trifles," in which are included the various imitations of foreign verse in English. The discussion of the sonnet, too, though failing to bring out fully the spiritual nature of this difficult verse form, is more accurate than might be expected from the following sentence: "The form of the sonnet is of Italian origin, and came into use in the fifteenth [*sic*] century, towards the end of which its construction was perfected, and its utmost melodious sweetness attained in the verse of Petrarch and Dante." In the chapter on Alliteration there are several misleading statements, such as calling "Piers the Plowman" an "Old English" poem. In the bibliography one is surprised not to find Mr. F. B. Gummere's admirable "Handbook of Poetics," now in its third edition. In spite of these and other shortcomings, which can be readily corrected in a later issue, this work may be recommended as a satisfactory treatment of the mechanics of verse. A careful reading will improve the critical faculties.—*The Dial.*